Greenhouse Monitoring System

Dr El-Shimaa Nabil

Submitted by :

Ebraheem Mohamed Said

Alaa Ameen Ali

Alaa Samy Esmail **(Team leader)**

Eman Atef Khodary

Tasneem Ashraf Elsayed

Menna Tallah HeshamEbied

Maha Adel Mohamed

Literature Review

A comparative analysis of existing greenhouse monitoring systems:

Reference	Description	Analysis & Tools	Pros	Cons	Design & Implementation
"Towards Autonomous Greenhouses Solar-Powered"	A solar-powered greenhouse system using fuzzy logic control to optimize microclimate (temperature, humidity, soil moisture) while conserving energy and water. Designed for remote/off-grid agricultural use.	- Hardware: Raspberry Pi, Arduino Duo, DHT22 (temp/humidity), VH400 (soil moisture), HC-SR04 (water level), MX5060 (battery voltage), PV panels, lead-acid batteries. - Software: Java, Vert.x (reactive toolkit), Fuzzy Logic Controllers (FLC), MySQL.	- Energy-efficient (solar-powered). - Adaptive fuzzy logic for precise control. - Multithreaded design enables real-time monitoring. - Prevents dry-running of solar components.	- High initial cost (PV system, batteries). - Limited scalability for large farms. - Dependency on weather (solar energy). - Complex setup (requires Java/Vert.x expertise).	- Sensing: DHT22, VH400, HC-SR04, MX5060. - Control: Three fuzzy logic controllers (humidity, temperature, irrigation) with supervisor logic. - Actuators: DC/AC motors (ventilation, humidification, solar pump). - Power: 24V battery bank + PV arrays. - Software: Vert.x for multithreading, MySQL for local storage, HTTP server for remote access.
"Wireless Sensor Networks for Precision Agriculture"	A review of NPK (Nitrogen, Phosphorus, Potassium) sensor implementations in Wireless Sensor Networks (WSNs) for precision agriculture, focusing on soil nutrient monitoring to optimize fertilizer use and crop yields.	- Sensors: NPK sensors (ion-selective, NIR spectroscopy, soil impedance), DHT22 (temp/humidity), soil moisture sensors. - Communication: Zigbee, LoRa, GPRS, Bluetooth. - Data Processing: WSN algorithms, grid/tessellation topologies.	- Real-time nutrient monitoring. - Reduces fertilizer waste and environmental impact. - Scalable for large farms. - Supports diverse crops (fruit, vegetable, plantation).	- High initial deployment cost. - Sensor calibration challenges. - Limited battery life in remote nodes. - Complex data synchronization.	- Sensor Layout: Hybrid (horizontal + vertical) with grid/tessellation patterns. - Transmission: Zigbee (low power) or LoRa (long-range). - NPK Ranges: Customized per crop (e.g., Banana: N-620 kg/ha, P-310 kg/ha, K-620 kg/ha). - Power: Solar/battery hybrid for off-grid use.
"AI-Powered Smart Greenhouses for Climate Control and Crop Growth	An AI-driven smart greenhouse system using machine learning (ML) and IoT to optimize climate control (temperature, humidity, CO_2, light) and crop growth, enhancing yield and sustainability.	- AI/ML: Deep neural networks, reinforcement learning. - Sensors: Temperature, humidity, CO_2, soil moisture, computer vision (plant health). - Automation: IoT actuators for HVAC, irrigation, lighting.	- 20–30% higher crop yield. - 15–25% reduction in water/energy use. - Early disease detection via computer vision. - Climate change resilience.	- High initial cost (~$50k for full setup). - Complex data management. - Requires ML expertise. - Dependency on high-quality training data.	- Hardware: IoT sensor network, AI server (edge/cloud). - Software: ML models (Python/TensorFlow), real-time analytics dashboard. - Actuators: Automated vents, LED lights, drip irrigation. - Crops Tested: Tomatoes, leafy greens, cucumbers.

"IoT-based Smart Greenhouse with Disease Prediction using Deep Learning"	An IoT-enabled smart greenhouse system integrating real-time environmental monitoring, automated irrigation, and deep learning-based disease prediction for crops like tomatoes and corn.	- Hardware: Raspberry Pi 3, DHT11 (temp/humidity), soil moisture sensors, 5V relay module. - AI/ML: Faster R-CNN (80.4% accuracy), SSD MobileNet, EfficientDet D0. - Cloud: ThingSpeak for data storage/alerting.	- Real-time monitoring (temp, humidity, soil moisture). - Automated irrigation (water savings ~25%). - Early disease detection (80%+ accuracy). - Cloud-based remote access.	- Limited to 1 camera per unit (scalability issues). - DHT11 sensor latency (~2 sec readings). - Requires stable Wi-Fi for cloud connectivity.	- Monitoring: DHT11 + soil sensors → Raspberry Pi → ThingSpeak cloud. - Irrigation: Relay-controlled motor triggered by soil moisture thresholds. - Disease Prediction: Faster R-CNN trained on 1,000 leaf images (800 train, 200 test).
"Analyzing the efficiency of Arduino UNO microcontroller in monitoring and controlling the microclimatic parameters of greenhouse"	A low-cost Arduino UNO-based greenhouse monitoring system for controlling temperature, humidity, and soil moisture using solar power, targeting small-scale farmers in Bangladesh.	- Hardware: Arduino UNO R3, DHT11 (temp/humidity), soil moisture sensors, 20W solar panel. - Software: Arduino IDE for threshold-based control logic. - Actuators: Cooling fans, drip irrigation pump.	- 80% cost reduction vs. commercial systems. - Solar-powered for off-grid use. - Real-time LCD display of parameters. - Automated fan control (±1°C accuracy).	- Limited to 3 parameters (no CO_2/light monitoring). - DHT11 sensor latency (2-sec delay). - No cloud/remote access capability.	- Sensors: 4× DHT11, soil moisture probes at 15cm depth. - Control Logic: Fans activate at >29°C; irrigation triggers below 500 soil moisture units. - Power: 12V battery + 20W solar panel.
"Monitoring of Smart Greenhouse"	A ZigBee-based wireless monitoring system for greenhouses that tracks temperature, humidity, and light intensity, with remote control via Android app. Targets precision agriculture with real-time adjustments.	- Hardware: LM35 (temp), LDR (light), capacitive humidity sensors, ZigBee XBee modules. - Software: Android app for remote control, RS232 serial communication. - Protocol: ZigBee (802.15.4) for WSN.	- Low-cost (~$100 per node). - Long battery life (years). - 300m range (outperforms Bluetooth/Wi-Fi). - Real-time alerts and actuator control (fans, curtains, sprinklers).	- Limited to 250 Kbps data rate. - No AI/ML for predictive control. - Requires manual intervention via app. - No cloud storage (local PC only).	- Sensing: Analog sensors → ADC → Microcontroller. - Communication: ZigBee mesh network → PC (RS232) → Android app. - Control: Threshold-based fan/curtain/sprinkler activation.
"Greenhouse Monitoring and Control System Using IoT"	The project focuses on developing a Greenhouse Monitoring and Control System using IoT to automate and optimize plant growth conditions. It replaces manual supervision with sensors (temperature, humidity, light, soil moisture) and an Arduino UNO microcontroller. Data is stored in the cloud and can be monitored/controlled via an Android app.	-Sensors: Light, temperature, moisture, and humidity sensors collect environmental data. -Microcontroller: Arduino UNO processes sensor data and triggers actuators (fans, LEDs, water pumps). -Cloud/App: Data is stored in the cloud; an Android app provides real-time monitoring and control. -Power Supply: 5V DC powers the system.	-Automation: Reduces manual labor and human error. -Efficiency: Optimizes plant growth conditions (light, water, temperature). -Remote Access: Cloud and app enable monitoring from anywhere. -Cost-Effective: Low operational costs and energy-efficient.	-Dependence on Connectivity: Requires stable internet for cloud/app functionality. -Initial Setup Cost: Hardware (sensors, Arduino) may be expensive for small-scale farmers. -Maintenance: Sensors need calibration; system may fail if not maintained.	-Sensors detect deviations → Arduino triggers adjustments (e.g., fan cools if temperature rises). -Data is logged in the cloud; users override settings via the app.